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## Technical Description of the Community Land Model (CLM)

Keith W. Oleson

Yongjiu Dai

Gordon Bonan

Mike Bosilovich

Robert Dickinson

Paul Dirmeyer

Forrest Hoffman

Paul Houser

Samuel Levis

Guo-Yue Niu

Peter Thornton

Mariana Vertenstein

Zong-Liang Yang

Xubin Zeng

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Terrestrial Sciences Section  
Climate and Global Dynamics Division

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NATIONAL CENTER FOR ATMOSPHERIC RESEARCH  
BOULDER, COLORADO

# 1. Introduction

This technical note describes the physical parameterizations and numerical implementation of version 3.0 of the Community Land Model (CLM3.0) which is the land surface parameterization used with the Community Atmosphere Model (CAM3.0) and the Community Climate System Model (CCSM3.0). Chapters 1-11 constitute the description of CLM when coupled to CAM or CCSM, while Chapter 12 describes processes that pertain specifically to the operation of CLM in offline mode (uncoupled to an atmospheric model). This technical note, the CLM3.0 Developer's Guide (Hoffman et al. 2004), and the CLM3.0 User's Guide (Vertenstein et al. 2004) together provide the user with the scientific description, coding implementation, and operating instructions for CLM. The CLM Dynamic Global Vegetation Model (CLM-DGVM) is described in Levis et al. (2004).

## 1.1 Model History and Overview

### 1.1.1 History

The development of the Community Land Model can be described as the merging of a community-developed land model focusing on biogeophysics and a concurrent effort at NCAR to expand the NCAR Land Surface Model (NCAR LSM) to include the carbon cycle, vegetation dynamics, and river routing. The concept of a community-developed land component of the Community Climate System Model (CCSM) was initially proposed at the CCSM Land Model Working Group (LMWG) meeting in February 1996. Initial software specifications and development focused on evaluating the best features of three existing land models: the NCAR LSM (Bonan 1996, 1998) used with the Community Climate Model (CCM3) and in the initial version of CCSM; the Institute of Atmospheric Physics, Chinese Academy of Sciences land model (IAP94) (Dai and Zeng 1997); and the Biosphere-Atmosphere Transfer Scheme (BATS) (Dickinson et al. 1993) used with CCM2. A scientific steering committee was formed to review the initial specifications of the design provided by Robert Dickinson, Gordon Bonan, Xubin Zeng, and Yongjiu Dai and to facilitate further development. Steering committee members were selected so as to provide guidance and expertise in disciplines not generally well-represented in land surface models (e.g., carbon cycling, ecological modeling, hydrology, and river routing) and included scientists from NCAR, the university community, and government laboratories (R. Dickinson, G. Bonan, X. Zeng, Paul Dirmeyer, Jay Famiglietti, Jon Foley, and Paul Houser).

The specifications for the new model, designated the Common Land Model, were discussed and agreed upon at the June 1998 CCSM Workshop LMWG meeting. An initial code was developed by Y. Dai and was examined in March 1999 by Mike Bosilovich, P. Dirmeyer, and P. Houser. At this point an extensive period of code testing was initiated. Keith Oleson, Y. Dai, Adam Schlosser, and P. Houser presented preliminary results of offline 1-dimensional testing at the June 1999 CCSM Workshop LMWG meeting. Results from more extensive offline testing at plot, catchment, and large scale (up to global) were presented by Y. Dai, A. Schlosser, K. Oleson, M. Bosilovich, Zong-Liang Yang, Ian Baker, P. Houser, and P. Dirmeyer at the LMWG meeting hosted by COLA (Center for Ocean-Land-Atmosphere Studies) in November 1999. Field data used for validation included sites adopted by the Project for Intercomparison of Land-surface Parameterization Schemes (Henderson-Sellers et al. 1993) (Cabauw, Valdai, Red-Arkansas river basin) and others [FIFE (Sellers et al. 1988), BOREAS (Sellers et al. 1995), HAPEX-MOBILHY (André et al. 1986), ABRACOS (Gash et al. 1996), Sonoran Desert (Unland et al. 1996), GSWP (Dirmeyer et al. 1999)]. Y. Dai also presented results from a preliminary coupling of the Common Land Model to CCM3, indicating that the land model could be successfully coupled to a climate model.